and parietal layer of extra embryonic mesoderm. Chorion give rise to projections called chorionic villi which will form placenta. Thus chorion provides nutrition to embryo.

chorionic villi

Amnion : It is a fetal membrane formed by the cells forming the wall of amniotic cavity and visceral layer of extra embryonic mesoderm close to connecting stalk. Amnion is greatly expanded and stretched due to growth and folding of embryo. Thus the embryo is covered by amnion from all the sides. Amnion play important role in parturition.

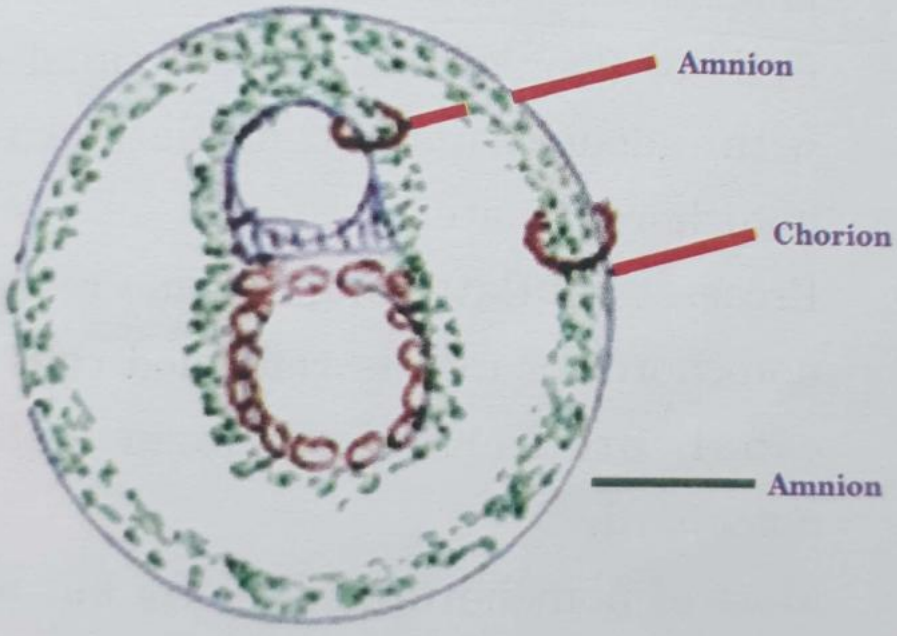

Fig. Chorion & Amnion

NOTOCHORD :

Definition :

It is a midline structure which extends from primitive streak to prochordal plate.

Stages of development :

- Cells of primitive streak become thick to form primitive knot or node./Henson's node
- Depression appears in primitive knot called blastopore.
- Cells of primitive knot multiply and pass cranially between ectoderm and endoderm up to prochordal plate.
- These cells form a solid cord called as notochordal process.
- Cavity of blastopore extends into notochordal process and converts it into notochordal canal.
- Cells of floor of notochordal canal mix up with endoderm and become flattened to form notochordal plate.
- Processes of flattening become reverse and notochordal canal is reformed cells of this canal proliferate to form definitive notochord.
- Most of notochord disappears but remains as nucleus pulposus of inter vertebral disc and apical ligament of dens.

Functions :

- It induces formation of neural tube i.e.

C.N.S.

- It forms central axis of body.

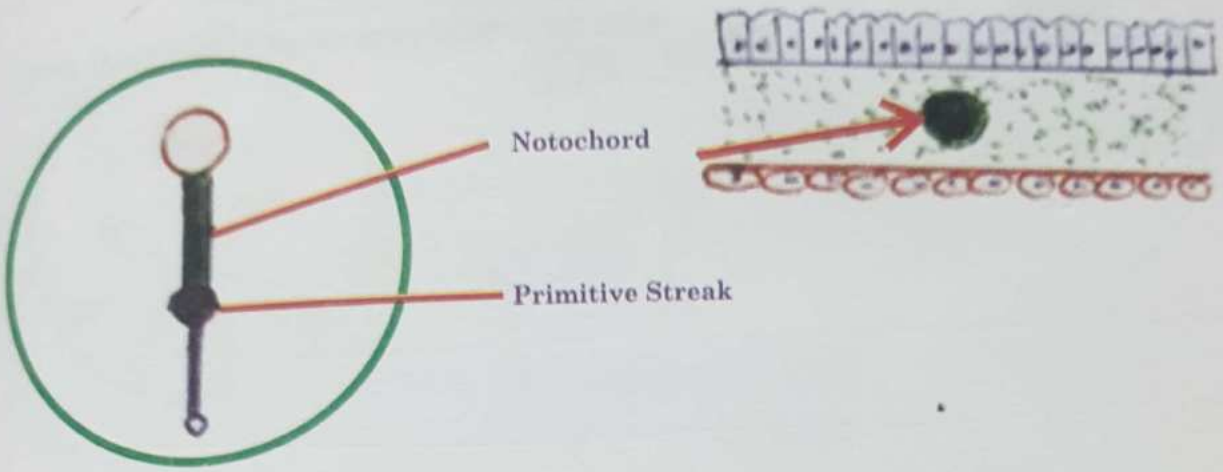

Fig. Notochord

LBN

PROCHORDAL PLATE :

- At the stage of secondary yolk sac the embryo is a circular disc composed of ectoderm and endoderm. There is no indication of head or tail end of emrbyo.

- Then at one circular area near margin of disc the cubical endodermal cells become columnar. This area is called prochordal plate. This is the head end of the embryo.

Functions :

- It decides the head end of embryo.
- It determines the central axis of embryo so

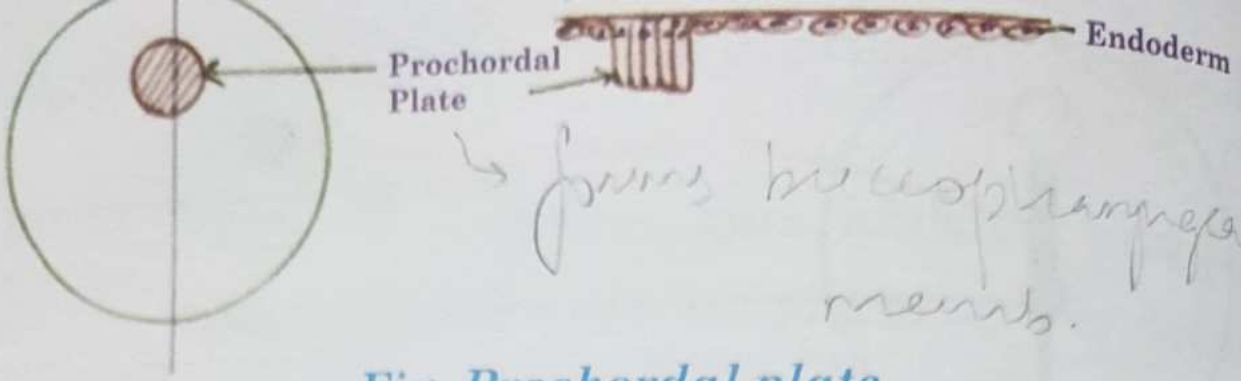

Fig. Prochordal plate

PRIMITIVE STREAK :

- After the formation of prochordal plate some of the ectodermal cells near the tail end of the embryo start proliferating.
- These ectodermal cells produce an elevation into the amniotic cavity.
- This bulge is called primitive streak.
- At first the primitive streak is rounded but soon it become elongted.

Functions :

- The cells of primitive streak give rise to third germ layer called as intra embryonic or secondary mesoderm.
- Cells of primitive streak become thick to form primitive node or knot which induces the formation of notochord.
- The process of formation of primitive streak

and secondary mesoderm is called gastrulation.

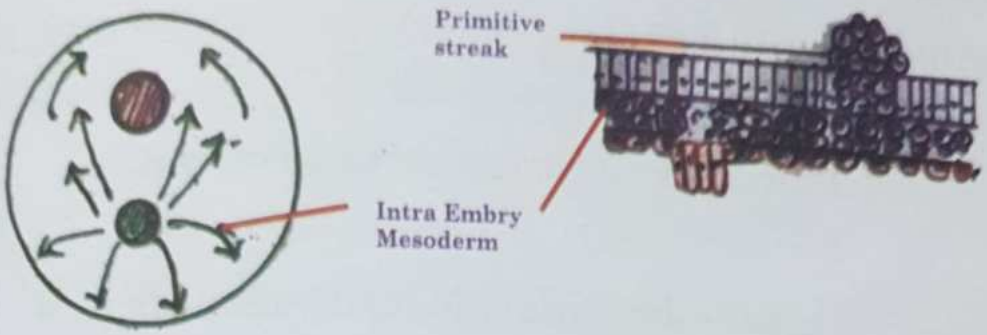

Fig. Primitive streak

INTRAEMBRYONIC MESODERM:

- It is the third germ layer also called as secondary mesoderm.
- It develops from proliferation of the cells of primitive streak.
- Intraembryonic mesoderm spreads between ectoderm and endoderm throughout the embryo except at the region of prochordal plate which forms buccopharyngeal membrane.
- Intraembryonic mesoderm also does not extend in the area caudal to primitive streak which forms the cloacal membrane. Beyond this the mesoderm extends into connecting stalk.
- Towards the margin of embryo the intraembryonic mesoderm is continuous

with extraembyonic mesoderm.

Subdivisions of Intraembryonic mesoderm:

It is divided into 3 parts.

- **Paraxial mesoderm**
  It becomes segmented to form somites.
- **Lateral plate mesoderm**
  Intraembryonic coleom develops in it.
- **Intermediate mesoderm**
  It forms genitourinary system.

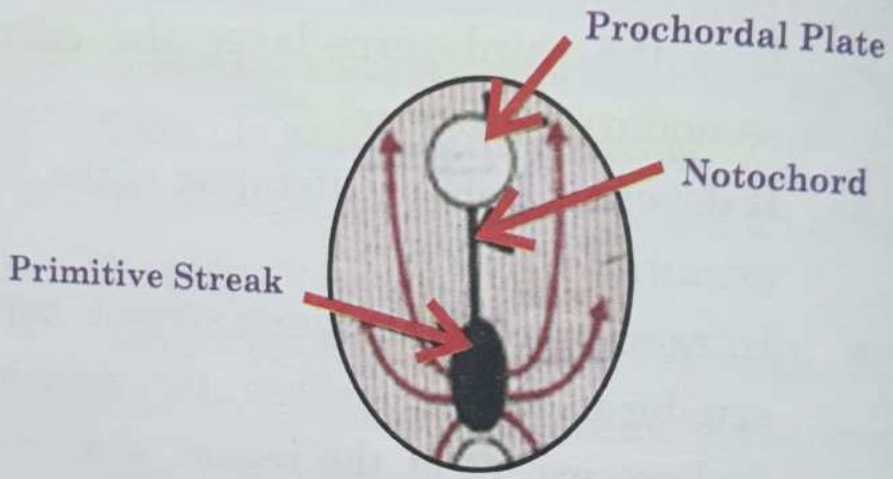

Fig.-Intraembryonic mesoderm

INTRAEMBRYONIC COLEOM:

- Cavity appears in lateral plate mesoderm called as intraembroynic coelom.
- It is a horse shoe shaped cavity having two lateral limbs connected in midline cranial to prochordal plate. It communicates with extraembryonic coelom.

- Two umbilical arteries and left umbilical vein.

PLACENTA AND CHORIONIC VILLI :

- Fingerlike projections which arise from the chorion are called chorion villi.
- These villi constitute the functional unit of placenta.
- Chorionic villi are formed along all sides of trophoblast.
- Soon the villi towards decidua capsularis degenerate and forms smooth area called chorion leavae.
- Chorionic villi grow deep in decidua basalis and forms the placenta, this part of chorion is called chorion frondosum

Stages of formation of villi :

I) Primary villi :

- Traphoblast differentiates into 2 layers.
- Superficial layer towards decidua basalis is called syncytiotrophoblast.
- Deeper layer is called cytotrophoblast.
- Spaces appear in syncytiotrophoblast called as lacunae.
- Blood vessels of endometrium open in the lacunae.

- Parts of syncytium between the lacunae are called trabculae.
- Now cytotrophoblast invade the trabeculae to form primary villi.
- Thus primary villi consist of syncytiotrophoblast and core of cytotrophoblast.
- It is surrounded by maternal blood in the lacunae which coalesce to form intervillous space.

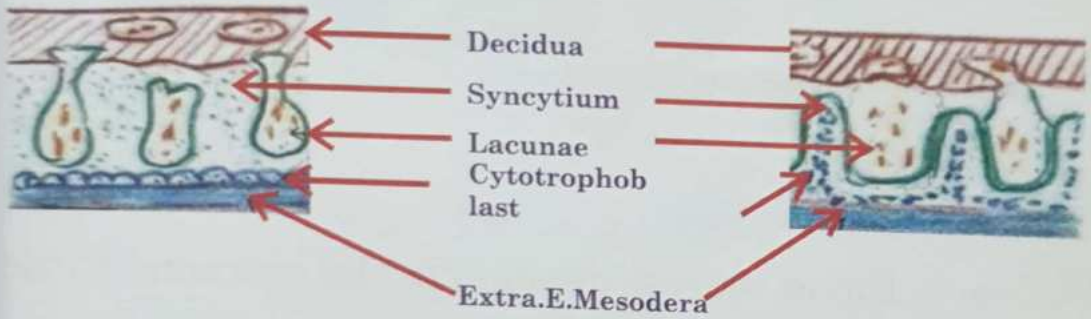

Fig. Primary Villus

II) Secondary villi :

- Parietal layer of extraembryonic mesoderm invades the primary villi to form secondary villi.
- Secondary villi consist of core of mesoderm covered by cytotrophoblast and syncytiotrophoblast.
- Maternal blood circulates into intervillous space.

- Still there is no development of feta capillaries so exchange is not occurring across the villi.

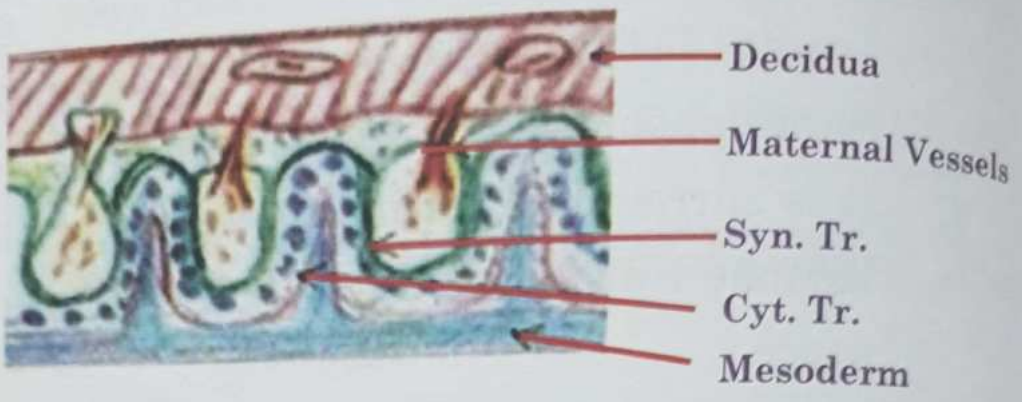

Fig Secondary Villus

III) Tertiary Villi :

- Blood vessels develop in the extraembryonic mesoderm of secondary villi to form tertiary villi.
- Now the exchange occurs between maternal blood present in intervillous space and fetal blood present in the capillaries of tertiary villi.

Placental membrane or barrier :

- It is formed by the structures forming walls of villi across which exchange occurs.
- It is formed by four structures.

- Endothelium of fetal capillary and its basement membrane.
- Surrounding mesoderm.
- Cytotrophoblast and its basement membrane.
- Syncytotrophoblast.

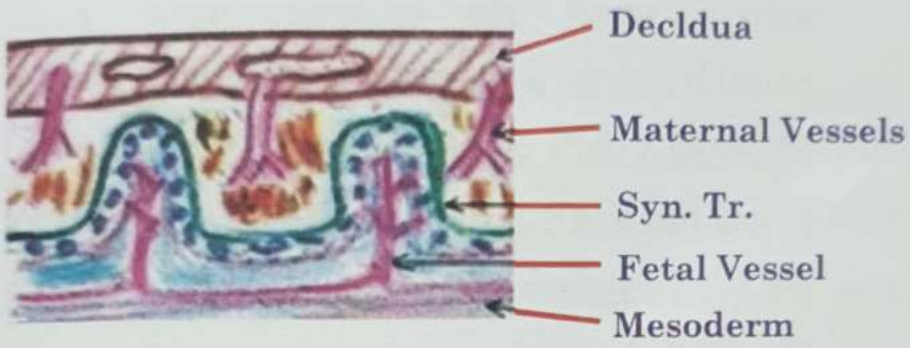

Fig. : Tertiary Villus

Types of villi

1. **Anchoring villi**

   Attached to fetal side to mesoderm and maternal side to cytotrophoblastic shell covering decidua basalis.

2. **Free villi**

   Arise from rami chorii (Branches of villi) and multiply to fill the intervillous space. This increases the surface area for exchange.

PHARYNGEAL ARCHES:

- Pharyngeal arches are mesodermal thickenings in the wall of foregut between stomatodeum and pericardium.
- There are six arches.
- Fifth arch disappears.
- Each arch is covered externally by ectoderm and internally by endoderm.
- The depression between arches are called ectodermal clefts and endodermal pouches.

I[ST] PHARYNGEAL ARCH:

Also called as Mandibular arch.

Derivatives of I[st] pharyngeal arch : Mesoderm of first arch has 4 elements i.e. skeletal (cartilage) muscle, artery and nerve.

Skeletal element:

- It is called meckel's cartilage.
- Its dorsal part forms malleus and incus.
- Ventral part is absorbed and is surrounded by mandible, maxilla, zygomatic, hard palate
- The middle part forms sphenomandibular ligament and anterior ligament of malleus.
- It also contributes to development of facial bones.

Muscle element : Tensor palati, Tensor tympani, Medial and Lateral ptreygoid, Masseter, Temporalis, Mylohyoid and Anterior belly of digastrics.

Nerve element : Mandibular nerve (Post trematic) and chorda tympani (Pretrematic).

Artery : Remains as 1st part of maxillary artery.

II[ND] PHARYNGEAL ARCH:

- It is also called hyoid arch:
- It is externally covered by ectoderm and internally covered by endoderm. The depression between 2nd and 3rd arch is called ectodermal cleft and endodermal pouch.

Derivatives of the II[nd] arch :

- It has 4 elements i.e. skeletal (cartilage), muscle, nerve and artery.

- **Skeletal element :**
- The dorsal part forms the stapes and styloid process.
- The middle part forms the stylohyoid ligament.

- The ventral part forms superior surface of body of hyoid and small cornu of hyoid bone.
- **Muscle element:** Muscles of facial expression, Stapedius, Stylohyoid, Posterior belly of digastric and platysma, occipitalis
- **Nerve :** Facial nerve.
- **Artery :** Stapedial artery.

III[RD] PHARYNGEAL ARCH :

- It has four elements i.e. skeletal (cartilage), muscle, nerve and artery.
- **Skeletal elements :** It forms greater cornu of hyoid bone and lower part of the body of hyoid bone.
- **Muscle elements :** Stylopharyngeous muscle.
- **Nerve element :** Glassopharyngeal nerve.
- **Artery :** Common carotid and Internal carotid artery.

IV[TH] PHARYNGEAL ARCH :

- It has four elements i.e. skeletal (cartilage) element, muscle, nerve and artery.
- **Skeletal element :** With VI[th] arch skeletal element It forms laryngeal cartilages like Thyroid, Cricoid, Corniculate and

Cuneiform, epiglottis.

- **Muscle element :** It forms muscles of the pharynx except stylopharyngeus, muscle of soft palate
- **Nerve element :** Superior laryngeal nerve.
- **Artery :** It forms proximal part of right subclavian artery and on left side contributes to arch of aorta.

VITH PHARYNGEAL ARCH :

- It consists of skeletal, muscle, nerve and artery elements.
- **Skeletal element :** With IVth arch It forms laryngeal cartilages.
- **Muscles :** It forms intrinsic muscles of larynx except cricothyroid.
- **Nerve :** Reccurent laryngeal nerve.
- **Artery :** Pulmonary arteries.

PHARYNGEAL CLEFTS :

These are ectodermal depressions between the arches.

First cleft :

- It is the depression between 1st and 2nd arch.
- Ventral part of the cleft is obliterated.
- Dorsal part of the cleft forms external

THYROID GLAND :

- After the development of pharyngeal arches, a midline swelling occurs between medial end of mandibular arches called tuberculum impar.
- From tuberculum impar endodermal diverticulum arise called thyroglossal duct.
- Thyroglossal duct grows down in the neck up to IVth pouch and bifurcates and cells of this diverticulum proliferate to form lobes of thyroid gland.
- Lateral thyroid from developed from IVth pouch also contributes to the gland.
- Para follicular cells develop from ultimobronchial body (Vth pouch).
- The capsule and connective tissue of thyroid gland develops from surrounding mesoderm.
- After development of gland thyroglossal duct degenerates to fibromuscular band called as levator glandulae thyroidae.
- Tuberculum impar remains as foramena caecum of tongue.

Anomalies:

- Pyramidal lobe on isthmus.
- Ectopic thyroid in larynx, trachea, oesophagus and pleura.
- Accessory thyroid - Lingual thyroid, suprahyoid thyroid, infrahyoid thyroid etc.
- Thyroglossal cyst and fistula - Persistant thyroglossal duct.

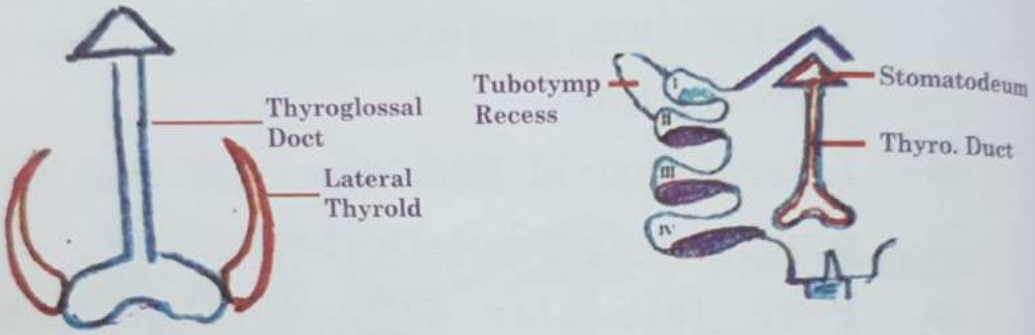

Fig Thyroid gland

DEVELOPMENT OF FACE :

- After the formation of head fold the depression bounded above by forebrain and below by pericardium is called as stomatodeum (Future Mouth).
- Lateral to the stomatodeum mandibular (I^{st}) arch lies.
- Above the stomatodeum median process called frontonasal process arises from the

mesoderm covering developing forebrain.

- Mandibular arch gives a bud from its dorsal end called as maxillary process. This maxillary process grows ventromedially towards frontonasal process to form upper lip and jaw.
- Lower part of Ist arch is now called mandibular process. This mandibular process grows medially and fuses with each other to form lower lip and jaw.
- Thus stomatodeum is now bounded above by frontonasal process, below by mandibular process and laterally by maxillay process.
- Nasal placodes arise on either side of frontonasal process which sink to form nasal pits. The edges of nasal pit become raised to form medial and lateral nasal process.
- The maxillary process, lateral nasal process, medial nasal process fuse with frontonasal process to form upper lip. Also nasal cavities are separated from stomatoderum.
- Cheek is formed by fusion of maxillary and mandibular processes.

DEVELOPMENT OF NASAL CAVITIES :

- Nasal cavities develop by extension of nasal

Maxillary process + lat & med. nasal process
↓
fuse & frontonasal process
↓
form upper lip

pits.

- Nasal septum is formed by frontonasal process.
- Paranasal sinuses develops as diverticuli from nasal cavity.
- Only maxillary and sphenoidal air sinus start developing before birth. Other sinuses develop after birth. Enlargement of sinus accounts for development of face.

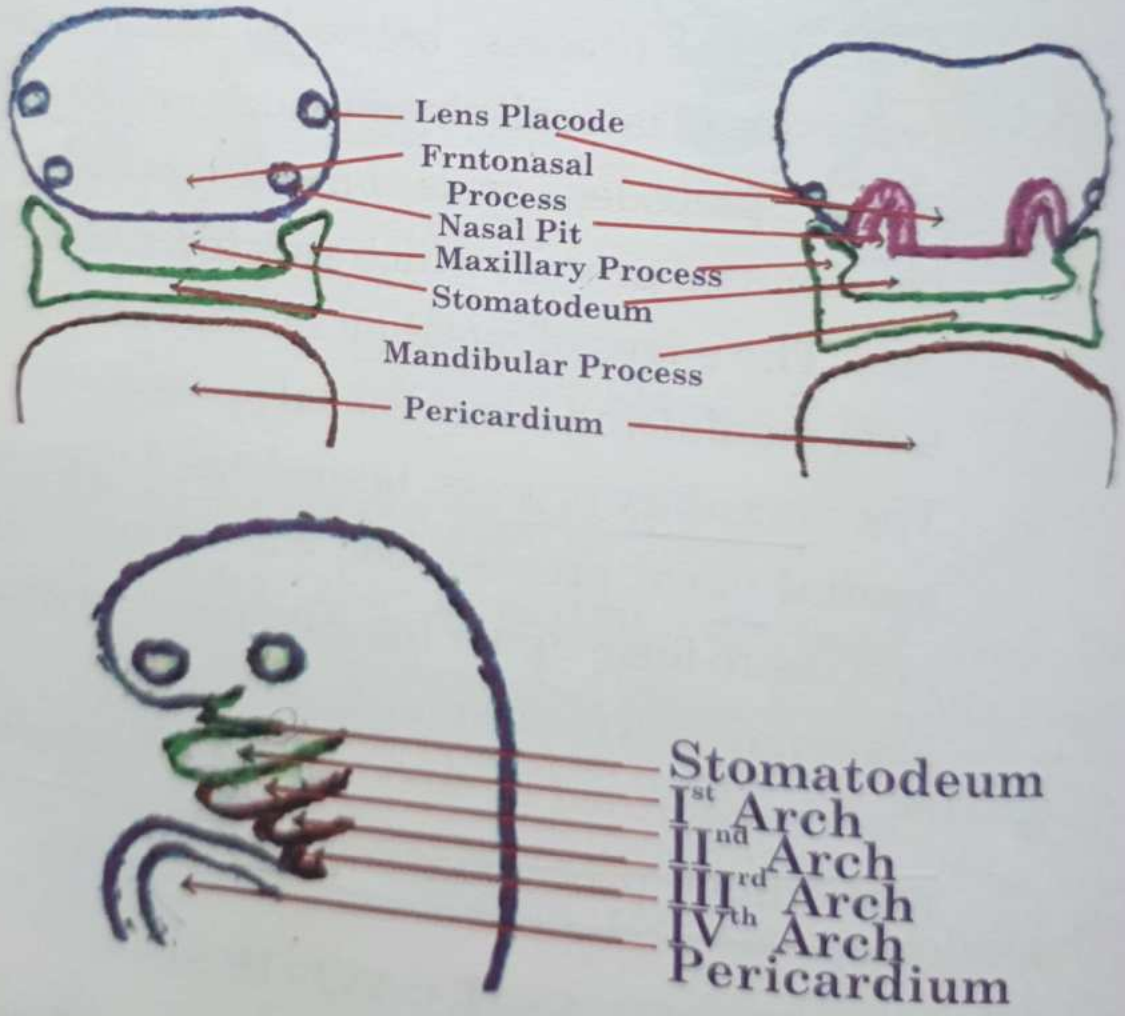

Fig. Development of face

Anomalis of face :

- **Harelip or cleft lip** - It is due to non fusion of maxillary and medial nasal processes. It may be unilateral or bilateral.
- **Oblique facial cleft** - Non fusion of maxillary and lateral nasal process.
- **Microstomia** - Over fusion of mandibular and maxillary process.
- **Macrostomia** - Inadequate fusion of mandibular and maxillary processes.
- **Retrognathia** - Small mandible.

- Supernumerary teeth
- Gemination (fused teeth)
- Malocclusion

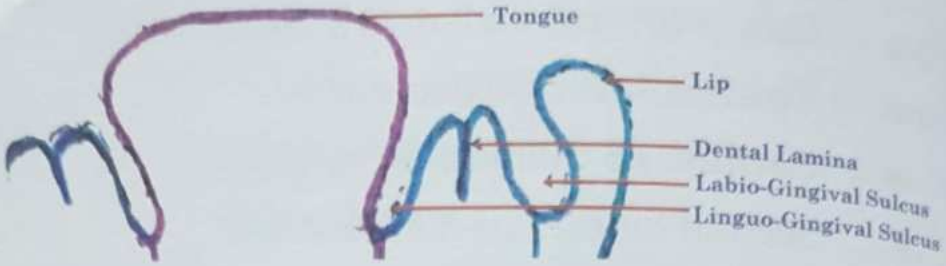

Fig. Development of tooth

DEVELOPMENT OF TONGUE :

Tongue develops in relation to pharyngeal arches in the floor of mouth as follows.

- Endoderm of medial ends of mandibular (Ist) arch proliferate to form two lingual swellings.
- These swellings are separated by a midline swelling called tuberculum impar.
- Thus anterior two third of tongue is formed by two lingual swellings.
- Tuberculum impar degenerates and remain as foramina caecum.
- Endoderm of medial ends of second, third and fourth arch proliferate and fuse to form hypobranchial eminence.
- The cranial part of this eminence forms

posterior one third of tongue and caudal part forms root of tongue and epiglottis.

- Endoderm of third arch overgrows the second arch thus posterior one third of tongue is formed only by third arch on the surface and the second arch is buried.
- This explains the nerve supply of tongue i.e Anterior two third is supplied by mandibular nerve, posterior one third is supplied by glossopharyngeal nerve and root of tongue is supplied by superior laryngeal nerve.
- Musculature of tongue develops from mesoderm of occipital myotomes. So it is supplied by hypoglossal nerve.

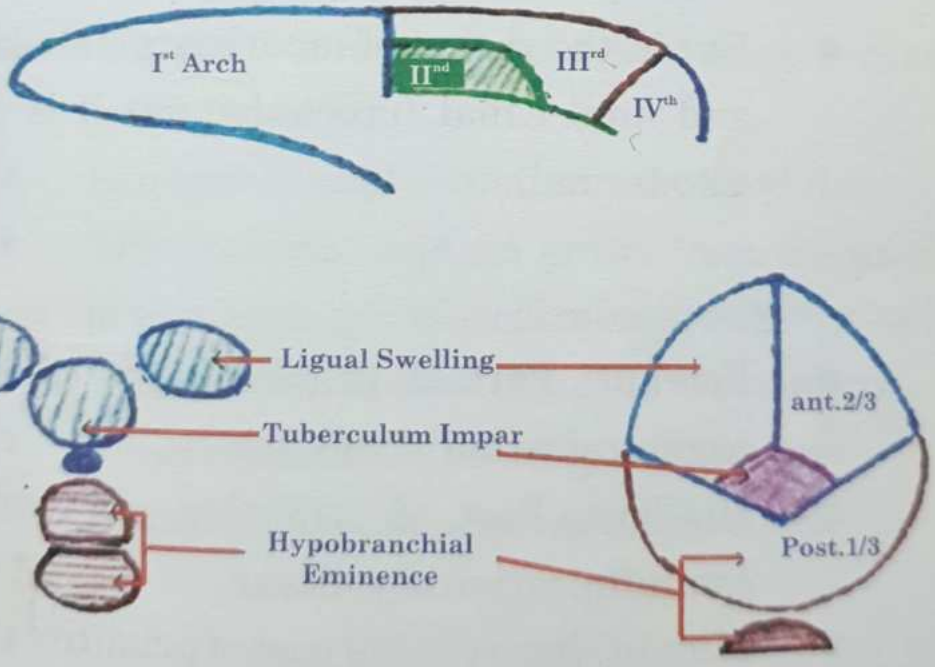

Fig.:Development of tongue

Anomalies of tongue :

- Macroglossia: Large tongue.
- Microglossia: Small tongue.
- Ankyloglossia: Tongue tie i.e. short frenulum.
- Bifid tongue: Non fusion of lingual swellings.
- Lingual thyroid: Accessory thyroid tissue in the Tongue.
- Persistant tuberculum impar: Red rhomboid area in front of foramina caecum.

- It elongates due to development of neck and decent of diaphragm.

DEVELOPMENT OF STOMACH :

- It develops as a fusiform dilatation of foregut distal to oesophagus.
- Stomach is suspended from posterior abdominal wall by dorsal mesogastrium.
- It is attached ventrally to septum transversum by ventral mesogastrium.
- Due to the development of liver and diaphragm the ventral mesogastrium is divided into lesser omentum, coronary ligament and falciform ligament.
- Similarly due to development of spleen and kidney the dorsal mesogastrium is divided into gastro splenic and linorenal ligaments.
- Muscle coat develops from splanchnopleuric mesoderm.
- Differential growth forms lesser and greater curvatures.
- Anomalies:
- Fusiform stomach.
- Hourglass stomach.
- Congenital pyloric stenosis.

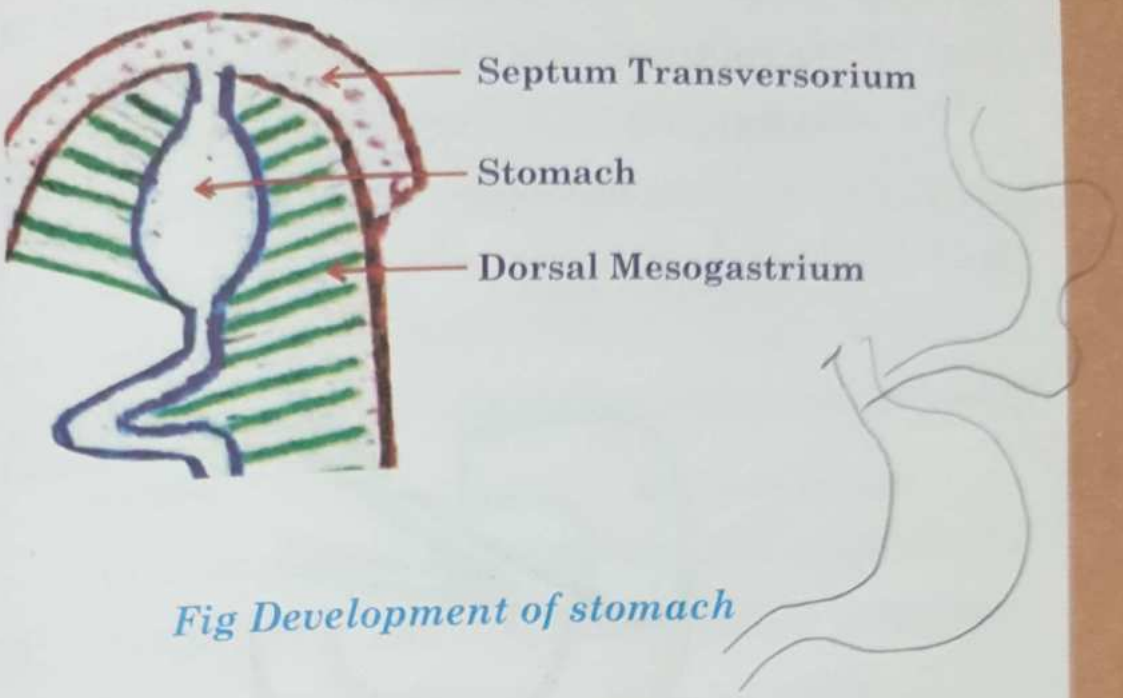

Fig Development of stomach

DEVELOPMENT OF DUODENUM :

- It develops from two sources.
- The first part and second part up to major doudenal papilla develops from endoderm of foregut.
- Remaining second part, third part and fourth part develop from pre-arterial segment of midgut.
- Duodenum is suspended by mesoduodenum from posterior abdominal wall.
- Later on the mesoduodenum is fused with parietal peritoneum so the duodenum becomes retroperitoneal except the first inch of first part.
- Muscle coat develops from splanchnopleuric

mesoderm.

- The blood supply of deuodenum can be explained by its development as it is supplied by coeliac trunk and superior mesentric artery. proximal part

distal part.

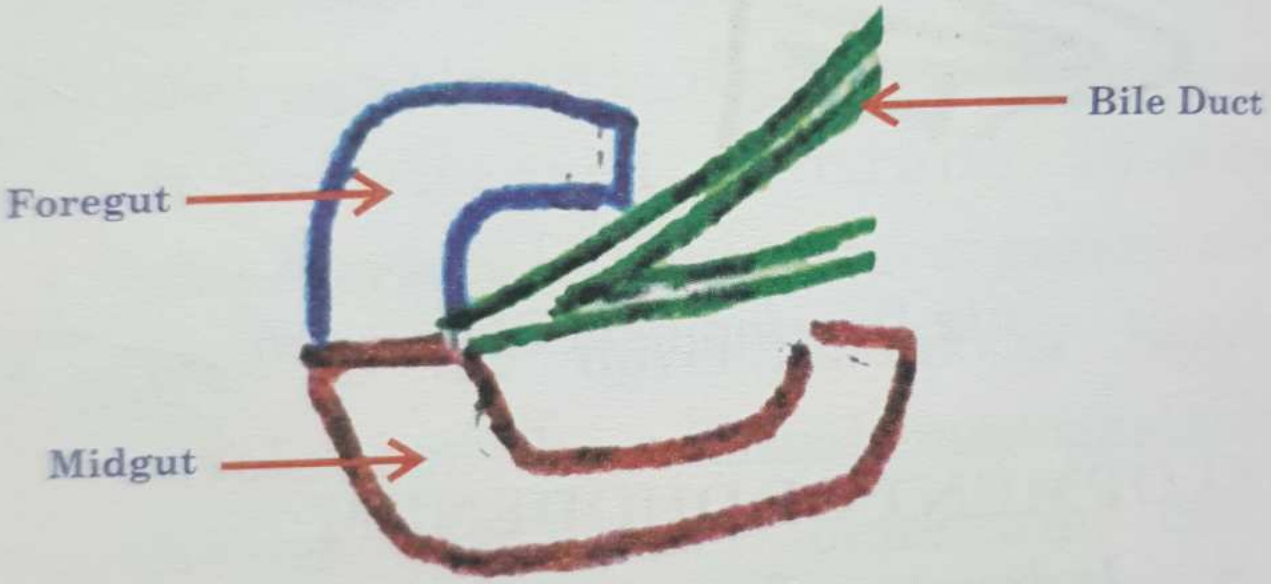

Fig.Development of Duodenum

DEVELOPMENT OF ANAL CANAL:

- It develops from two sources, partly from endoderm and partly from ectoderm.
- Above the pectinate line it develops from endoderm of primitive rectum.
- Below the pectinate line it develops from ectoderm of proctodaeum or anal pit.
- Sphincters of anal canal develop from splanchno pleuric mesoderm.
- Blood supply and nerve supply can be explained due to two sources of development.
- Anal membrane breaks down in later stages of development so that anal canal communicates to the exterior.

Anomalies:

- Imperforate anus: Persistant anal membrane.
- Recto vescical fistula.
- Recto vaginal fistula.

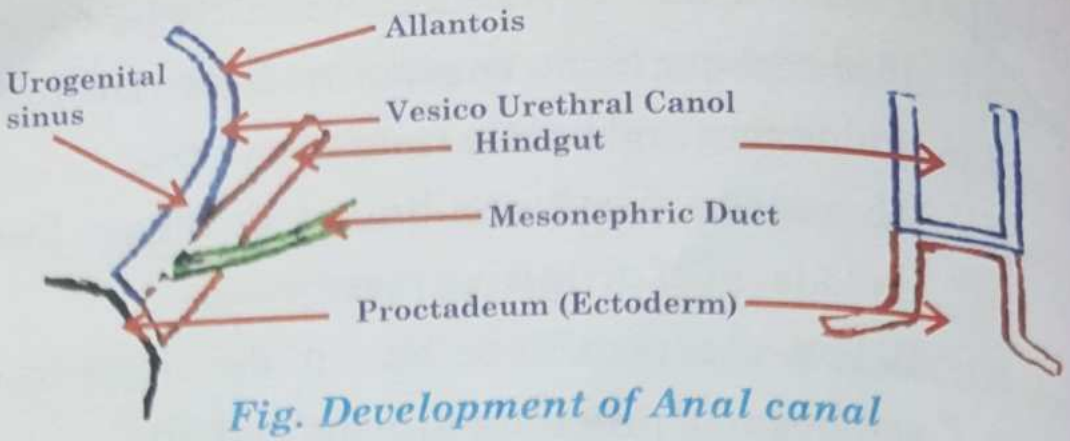

Fig. Development of Anal canal

VITELLO INTSTINAL DUCT (MECKEL'S DIVETICULUM):

- It is present in two percent of individual.
- It lies two feet away from ileocaecal junction
- It is two inches long.
- Vitello intestinal duct is a communication between midgut and definitive yolk sac.
- Normally it is obliterated, sometimes the duct may remain patent to form meckel's diverticulum or diverticulum ilei.
- This diverticulum is of surgical importance as it may contain gastric mucosa or pancreatic tissue which can cause inflammation.

Anomalies of vitello intestinal duct:

- Umbilical fistula: Peristant duct.
- Umbilical sinus: Patent distal part of duct.
- Vitelline cyst: Peristant middle part.

- Rasberry tumor: Growth at umbilicus.

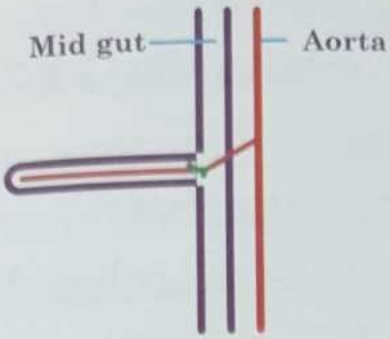

Fig. : Vitello intestinal duct

ROTATION OF GUT

- Due to faster growth midgut loop remains outside the umbilicus for some period.
- It has prearterial ventral and postarterial dorsal segment.
- First rotation:
- Preartial segment goes to right and post arterial segment goes to left.
- It is anticlockwise rotation by 90°
- Now prearterial segment increase in length to form coils of jejunum and ileum.
- Second rotation:
- Coils of intestine return into abdominal cavity.
- Due to rotation, the coils pass behind superior Mesenteric artery and occupy left and upper part of abdomen.
- It is also anticlockwise rotation by 90°

Transverse colon lies ant to SMA & caecum comes to lie on rt. side

- Third rotation
- Finally post arterial segment also return to abdominal cavity.
- It also rotates by 90 ° in anticlockwise direction.
- Effect of rotation:
- The transverse colon lies anterior and caecum lies on right side to the superior mesenteric artery.

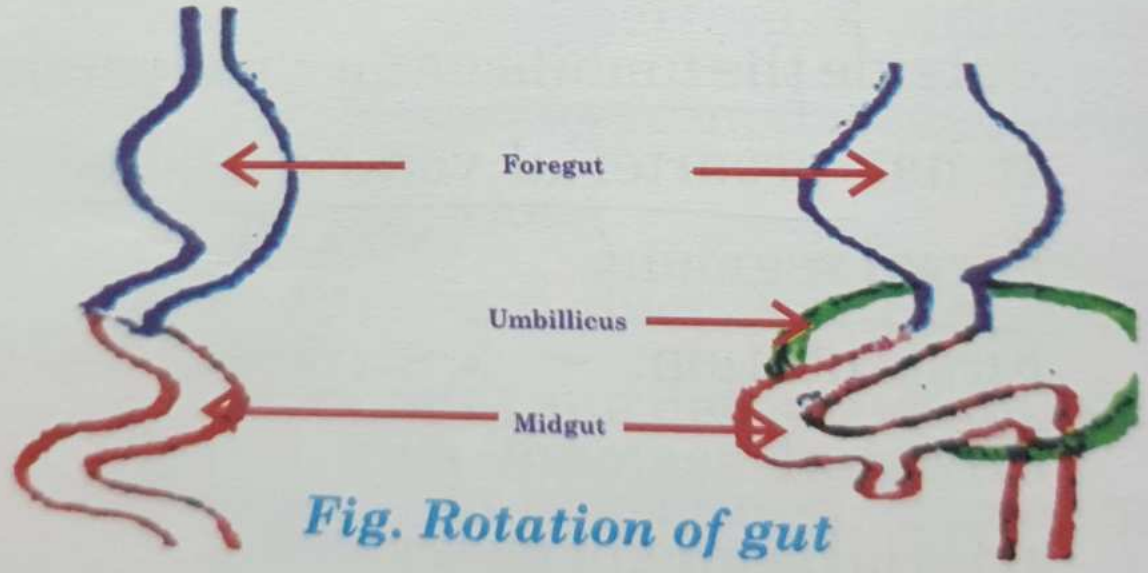

Fig. Rotation of gut

DEVELOPMENT OF DIAPHRAGM :

- It develops in the cranial part of the septum transervsum.
- The septum transversum is a mass of

mesoderm lying in the floor of pericardial cavity.

- It separates pericardium and peritoneum cavities. Posterior to it the pleuro peritoneal canals are closed by the membrane.
- Thus diaphragm develops from following sources
- Septum transversum forms the central tendon.
- Pleuro peritoneal membranes form the posterior parts.
- Ventral and dorsal mesentries of oesophagus from the midline part.
- Mesoderm of body wall forms the peripheral pars.
- The diaphragm migrates caudally during development so it retains the nerve supply from cervical plexus i.e phrenic nerve.
- Nerve supply of diaphragm by phrenic nerve indicates the descent of diaphragm due to elongation of neck and migration of septum transversum due to appearance of pharyngeal arches between stomadum and pericardium.

Anomalies:

1) Diaphragmatic hernia –It may be central, posterior or postero lateral, or restrosternal, hernia.

2) Accessory diaphragm- subdivides the right lung.

3) Eventeration of diaphragm - thin muscle.

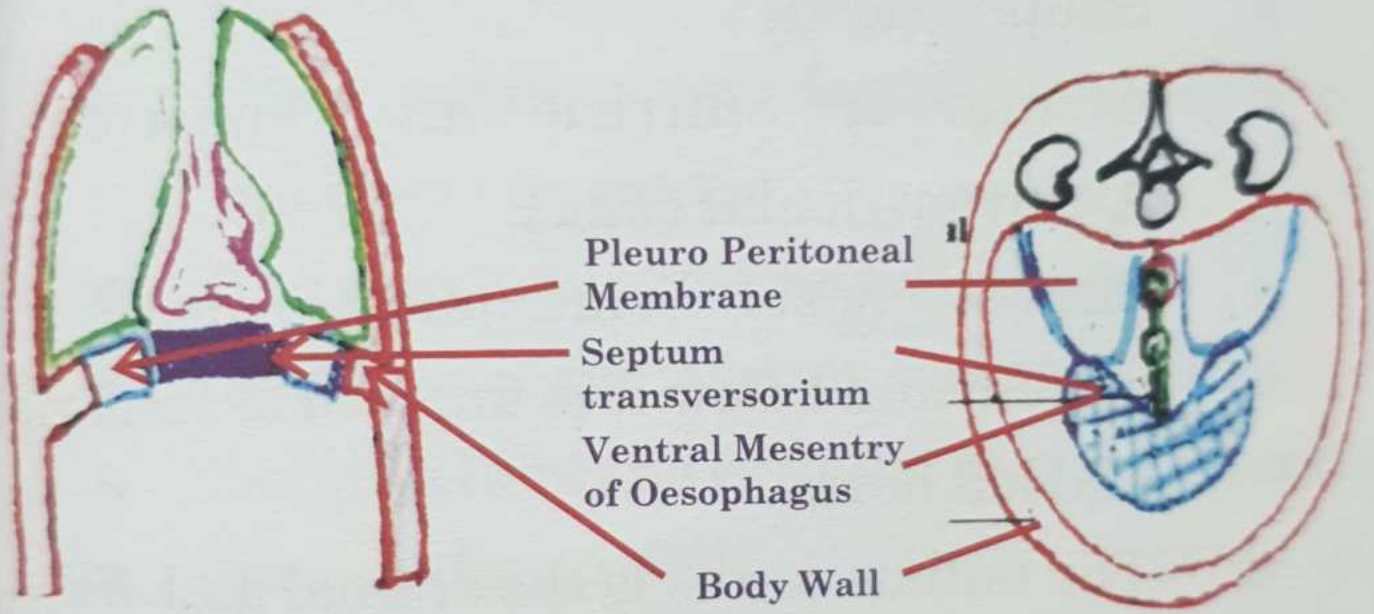

Fig.: Diaphragm

DEVELOPMENT OF HEART TUBE :

- Heart and blood vessels develop from mesoderm
- Heart is formed from cardiogenic area which is the splancnopleuric mesoderm in floor of pericardial cavity.
- Heart develops from two endothelial heart tubes appear in the cardiogenic area. They fuse craniocaudally.
- All parts of the cardio vascular system are mesodermal in origin.
- Heart is the first organ of the body to start

functioning

- Heart tube is divided into 4 parts
- Bulbus cordis
- Ventricle
- Atrium
- Sinus venosus
- Atrium & ventricle are connected by Atrioventricular canal.
- Sinus venosus communicate above with atrium and below it is unfused to form right and left horns.
- The bulbus cordis is the cranial and arterial end of heart.
- It is divided into lower part called conus and upper called truncus arteriosus.
- The truncus is continuous with aortic sac from which right and left first pharyngeal arch arteries. They are continous with dorsal aortae.
- Sinus venosus represent venous end of the heart tube. The horns of sinus venosus are joined by three veins.
- One vitelline vein from yolk sac, one umbilical vein from placenta and one common cardinal vein from body wall.

FATE OF THE HEART TUBE :

- Right horn of sinus venosus is absorbed into atrial chamber, and contributes to the formation of right atrium.
- Right common cardinal vein forms superior vena cava.
- Right vitelline vein forms terminal part of inferior vena cava.
- The right umbilical vein disappears.
- Left horn of sinus forms coronary sinus.
- Left vitelline and cardinal vein degenerates.
- The left umbilical vein carries the oxygenated blood from placenta.
- Atrial chamber is partitioned into right and left atria.
- Conus i.e bulbus cordis proper is absorbed into right ventricle to form bulboventricular loop.
- Truncus arteriosus is partitioned to form ascending aorta and pulmonary trunk.

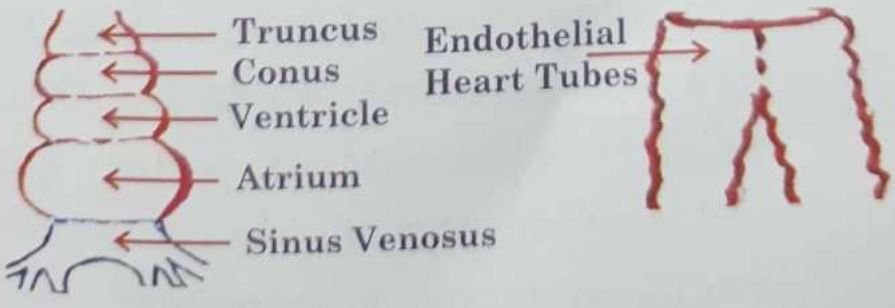

Fig.. Parts of the heart tube

DEVELOPMENT OF RIGHT ATRIUM & INTER ATRIAL SEPTUM :

A) Inter atrial septum :

- Left horn of sinus venous regresses and appears as tributary of right horn.
- The right horn now communicates with atrial chamber through sinuatrial orifice. The margins of S-A orifice are called right and left venous valves. They fuse to form septum spurium.
- Septum primum arise from the roof of atrial chamber to the left of septum spurium. It grows down and fuses with septum intermedium
- Septum intermedium arise from A-V cushions from the floor of atrial cavity.
- The septum primum and intermedium are separated by foramina primum. But after the fusion of two septa the foramina primum is closed.
- Now upper part of the septum primum breaks down to form foramina secundum.
- Now septum secundum arise from the roof of atrial chamber between septum spurium and septum primum. It grows down to overlap the foramena secundum.

- This oblique opening between two atria is called foramena ovale.
- Foramena ovale closes after the birth due to increase in pressure of left atrium. It is a mechanical closure.
- Septum primum remains as fossa ovalis & septum secundum remains as limbus fossa ovalis.

Right Atrium :

- After the formation of inter atrial septum the sinus venosus is absorbed into right atrium.
- The right and left venous valves of sinuatrial orifice become separated from each other. The right valve form the crista terminalis, valve of the inferior vena cava and coronary sinus the left valve is fused with interatrial septum.
- Thus the right atrium develops from these sources.
- The rough anterior part develops from primitive atrial chamber.
- The smooth posterior part develops from absorption of sinus venosus.
- The inter atrial septum develops from

septum spurium, primum, secondum and septum intermedium.

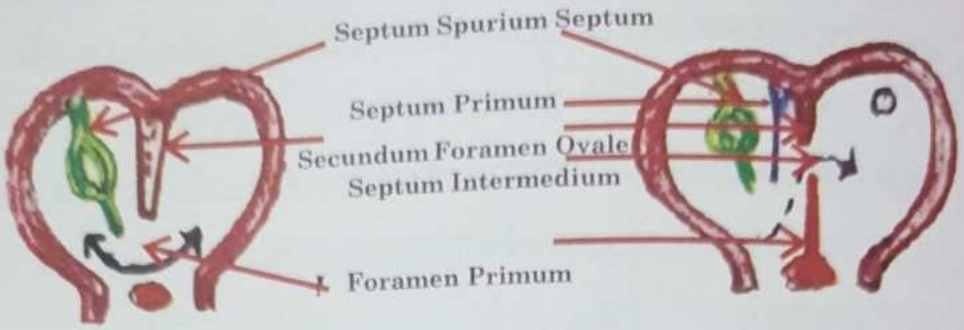

Fig : Development of right atrium and interatrial septum

Development of inter ventricular septum :

- The conus i.e. bulbus cordis merges with primitive ventricle to form bulboventricular cavity.
- It communicates in the lower part with atria through A-V canals and in the upper part with truncus arteriosus.
- Truuncus arteriosus is partioned by spiral septum into pulmonary trunk and aorta.
- The bulboventricular cavity is divided into right and left ventricles by development of inter ventricular septum as follows:
- An interventricular septum grows upwards from the floor of bulbo ventricular cavity. It meets above with A-V cushion (septum intermedium).
- Right and left bulbar ridges arise from the

wall of conus. They fuse to form bulbar septum. It grows down towards the interventricular septum but do not fuse.

- This gap is filled by proliferation of A-V cushions and it forms the membraneous part of interventricular septum.

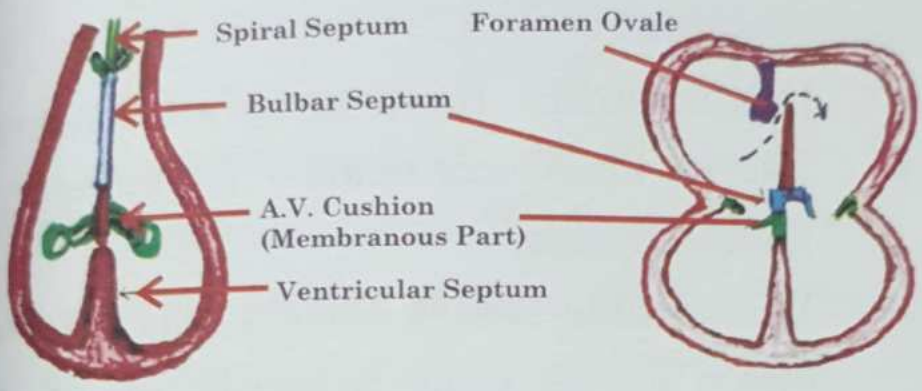

Fig. 49 : Interventricular septum

Development of ventricles

- Bulbus cordis is divided into proximal part called conus and distal part called truncus arteriosus .
- Truncus arteriosus is divided into 2 parts by spiral septum which forms pulmonary trunk and aorta.
- Conus is absorbed into ventricles . It is divided into two ventricles by septum (Inter ventricular septum)
- **Right ventricle** develops from two sources Rough inflowing part develops from

primitive ventricle and smooth upper outflowing part develops from conus.

- **Left ventricle** develops from 2 souces. The rough inflowing part develops from primitive atrial chamber and smooth part develops from absoption of pulmonary veins

Anomalies of heart :

- Dextro cardia - It is a part of situs inversus
- Patent foramena ovale - It causes cynotic heart disease.
- Ventricular septal defects may lead to two chambered (cor biloculare) or three chambered heart (cor triloculare)

Fallot's tetrology :

It consists of

- Ventricular septal defect
- Pulmonary stenosis
- Hypertrophy of right ventricle
- Over riding of aorta on both the ventricles

Tousing - Bing syndrome :

It consist of

- Aorta arise from right ventricle
- The pulmonary trunk over rides both ventricles

DEVELOPMENT OF KIDNEY :

It develops from nephrogenic cord which develops from intermediate mesoderm. The kidney passes through 3 stages of development.

1) **Pronephros** develop in cervical region from nephrogenic cord. It is functioning kidney in cyclostomes and fishes. It disappears in human soon.

2) **Mesonephros** arise in thoracolumbar region. It consist of mesonephric tubules which open into mesonephric duct.The mesonephric duct opens into cloaca. It is functioning in anamnitoes & reptiles.

3) **Metanephros** develop in sacral region which develops into definitive kidney in humans.

- Kidney develops from two sources.
- The excretory part develops from metanephric blastema which develops from medial side of metanephros.
- The collecting part develops from ureteric bud which arise from mesonephric duct. The ureteric bud grows cranially and dilates to form ampula.
- This ampula undergoes repeated divisions. First 3 to 5 generations fuse to form pelvis of kidney further divisions form major &

minor calyx and collecting tubules.

- Tip of each such division dilates to form ampula which comes in contact with cells of metanephric blastema.
- This contact induces its differentiation to form parts of the nephron.
- The ureter develops from ureteric bud.

Ascent of kidney :

- Kidney develops in sacral region then it ascends to the lumbar region by differential growth of body wall for getting better blood supply.
- Kidney rotates during the ascent so the hilum present on anterior side also shifts on medial side.

Anomalies :

1) Agenesis : Non development
2) Hypoplasia - under development
3) Horseshoe kidney - lower poles of two kidney united.
4) Pancake kidney - Two kidneys fuse in front of aorta.
5) Polycystic kidney - Failure of union of ureteric bud and metanephric blastema.

6) Lobulated kidney –Kidney with lobules.
7) Non ascent of kidney
8) Duplication of ureter

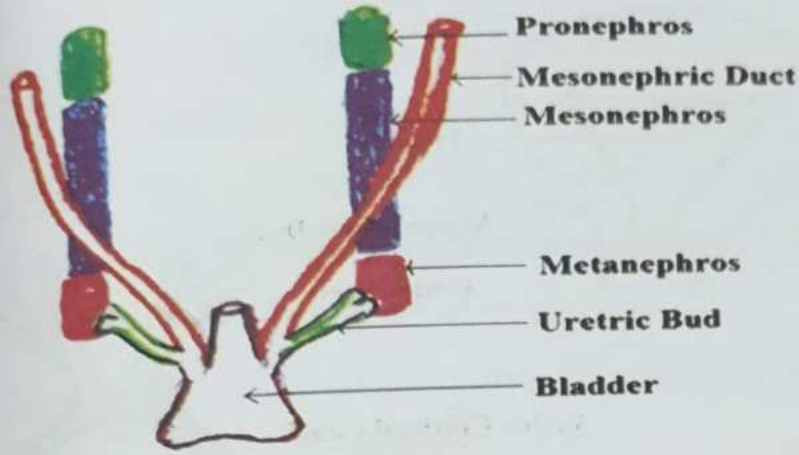

Fig. 54 : Development of kidney

URINARY BLADDER :

- The epithelium of the urinary bladder develops from endoderm of vesicourethral canal.
- The epithelium of trigone develops from absorption of mesonephric duct.
- The muscle and serous coat develop from splanchnopleuric mesoderm.
- Allantois may contribute to the apex of the bladder or gets obliterated and remains as urachus.

Anomalies :

1. Hourglass bladder
2. Ectopia vesicae i.e. bladder is exposed due to non development of anterior abdominal wall.

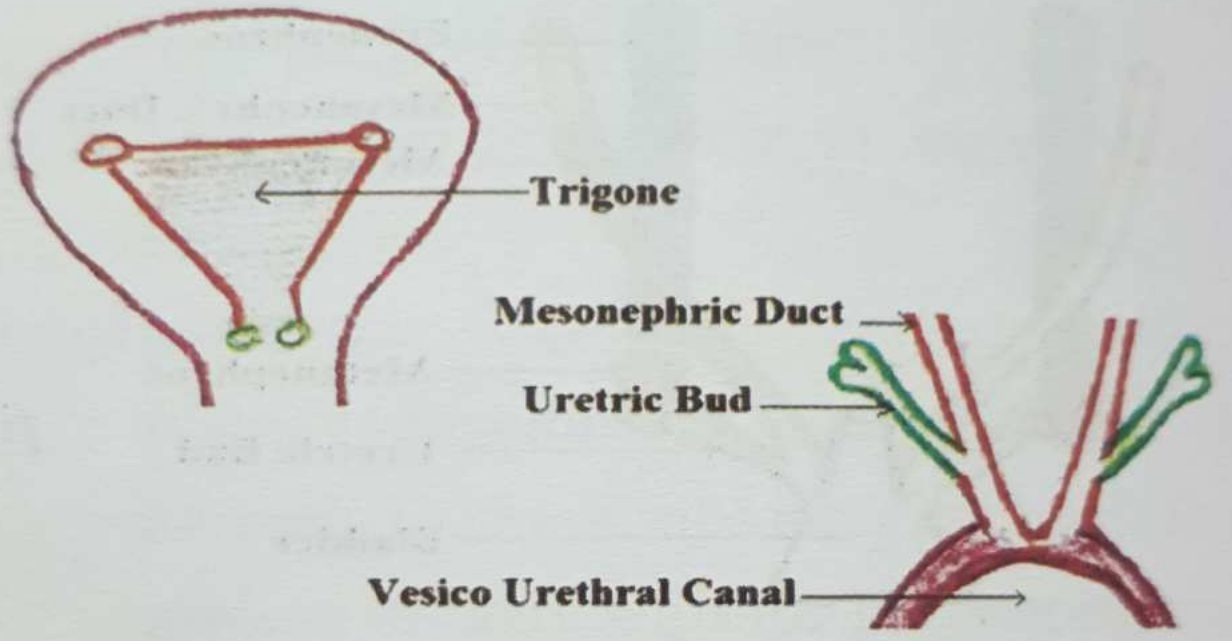

Fig Development of urinary bladder

PROSTATE:

- The prostate develops from the endodermal buds which arise from epithelium of caudal part of vesicourethral canal and upper part of pelvic part of urogenital sinus. These buds develop into outer glandular zone.
- The mesodermal buds which arise from posterior wall of urethra develop into inner glandular zone.
- Connective tissue and capsule devlop from splanchno pleuric mesoderm.
- In females these buds give rise to urethral glands and paraurethral glands of skenne.

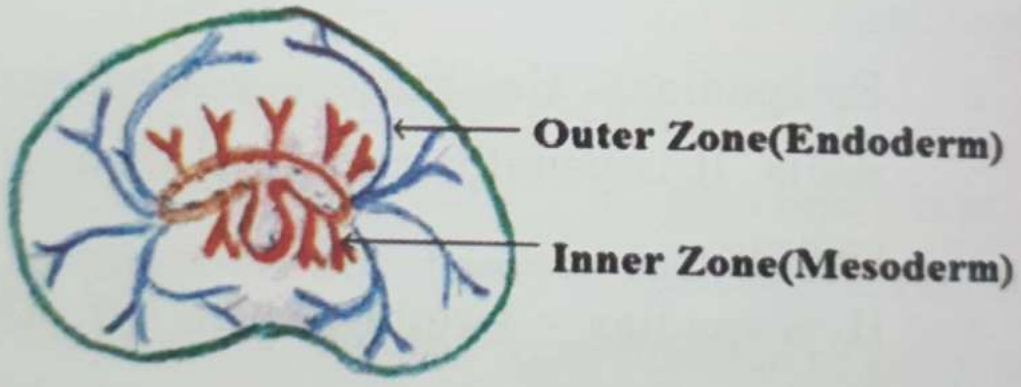

Fig.Prostate

MESONEPHRIC DUCT:

- It is the continuation of nephric duct which is formed in relation with pronephros it opens caudally into the cloaca, cranially it receives mesonephric tubules.

Derivatives of mesonephric duct in males :

1. Ureteric bud
2. Trigone of bladder
3. Posterior wall of urethra
4. Epididymis
5. Vas deferens
6. Seminal vesicles
7. Ejaculatory ducts.
8. Inner glandular zone of prostate
9. Appendix of epididymis - It is remnant of cranial end of the duct.
10. Vasa effrentia (Effrent ductules)
11. Superior aberrant ductules to testes
12. Inferior aberrant ductules connected to epididymis
13. Paradidymis present between tests and epididymis

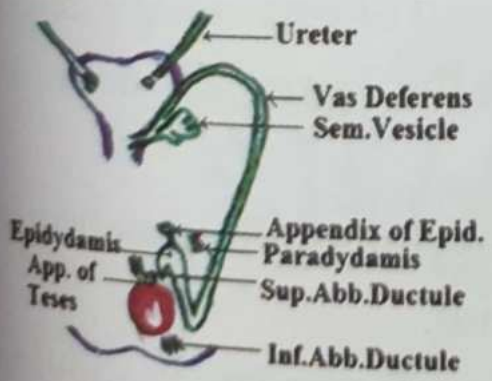

Fig. Duct in Male

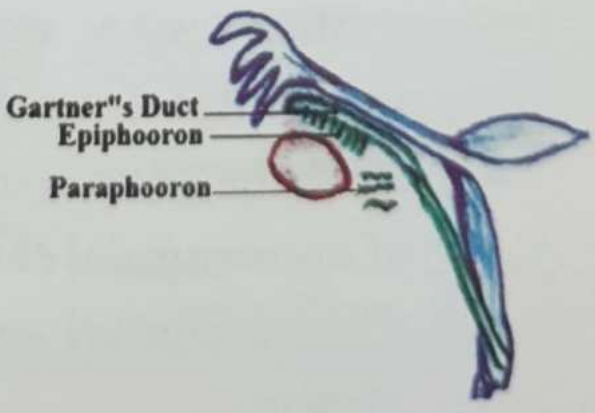

Fig. Duct in Female

B) Mesonephric duct in females :

1. Ureteric bud
2. Trigone of bladder
3. Posterior wall of urethra
4. Epoophoron and gartner's duct is a remnant of mesonephric duct in broad ligament of uterus.
5. Paroophoron - blind tubules in broad ligament (mesonephric) tubules.

DEVELOPMENT OF UTERUS & UTERINE TUBES (PARAMESONEPHRIC DUCTS)

- The paramesonephric ducts are present in the intermediate mesoderm lateral to the mesonephric ducts. They are formed by invagination of coelomic epithelium.
- Two ducts cross the mesonephric duct to medial side and fuse to form uterovaginal canal. The caudal end of this canal comes in contact with phallic part of definitive urogenital sinus.
- Now the uterus develops from canalization of uterovaginal canal.
- The urogenital sinus forms the vestibule of vagina.
- The unfused parts of the paramesonephric

ducts develop into uterine tubes.

- Thus the epithelium, muscle coat and serosa of uterus and uterine tubes is mesodermal in origin.
- These paramesonephric ducts degenerate in males and remains as appendix of testes and prostatic utricle.

Anomlie :

1) Unicornuate uterus
2) Bicornuate uterus
3) Septate uterus
4) Septate uterus with septate vegina
5) Duplication of uterine tubes

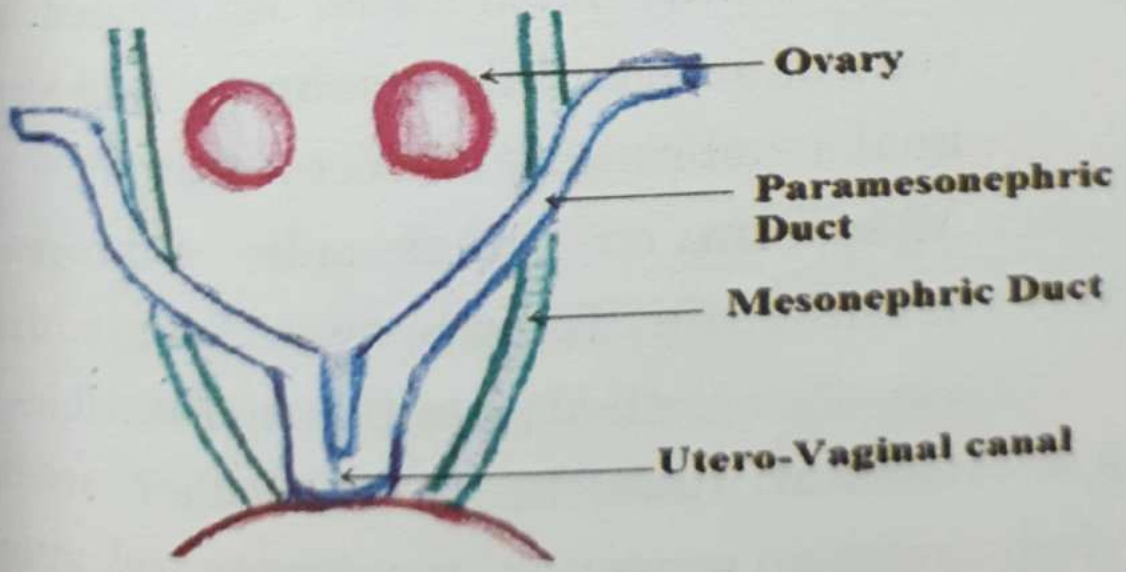

Fig. Development of uterus & fallopian tube

DEVEL

DEVELOPMENT OF TESTES :

The germ cells which form the spermatogonia develop early in fetal life from endoderm of wall of yolk sac. From it they migrate into developing testes.

- **Stages of development :**
- The coelomic epithelium which cover the medial side of mesonephros becomes thick to form genital ridge in the lumbar region.
- Cells of the genital ridge proliferate to form sex cords which grow into underlying mesenchyme.
- These sex cords become canalise to form the seminiferous tubules.

- Sex cords which are not canalised form the interstitial cells.
- Surrounding mesoderm form the tunica albugenia.

Descent of testes :

- Testes develop in lumbar region. Gradually they descent to scrotum.
- They reach iliac fossa in 3rd month, deep inguinal ring upto 7th month, pass through ingunial canal between 7th to 8th month.
- Finally they reach the scrotum in 9th month.

Factors for the descent :

- Differential growth of body wall.
- Formation of inguinal bursa: The layers of abdominal wall show outpouching towards the scrotum, it is called inguinal bursa. Testes enter the bursa during descent. The bursa forms the inguinal canal.
- Gubernaculum - It is a mesenchymal band extending from lower pole of testes to the scrotum. The relative shortening of the gubernaculum causes the descent.
- Processes vaginalis - It is a peritoneal diverticulum. It grows into inguinal canal

and reaches the scrotum. Testes invaginate this processus. After the descent it forms tunica vaginalis.

- Male hormones

Anomalies:

- Agenesis - Non development of testes.
- Monorchism - One testes absent.
- Cryptorchidism - Non descent of testes. Testes are found in pathway of descent. Patient is azospermic.
- Ectopic testes - It may be found under the skin of abdominal wall, thigh, penis, perineum & femoral canal. They may develop into cancer.
- Congenital hydrocele - Peristant cavity of processus vaginalis

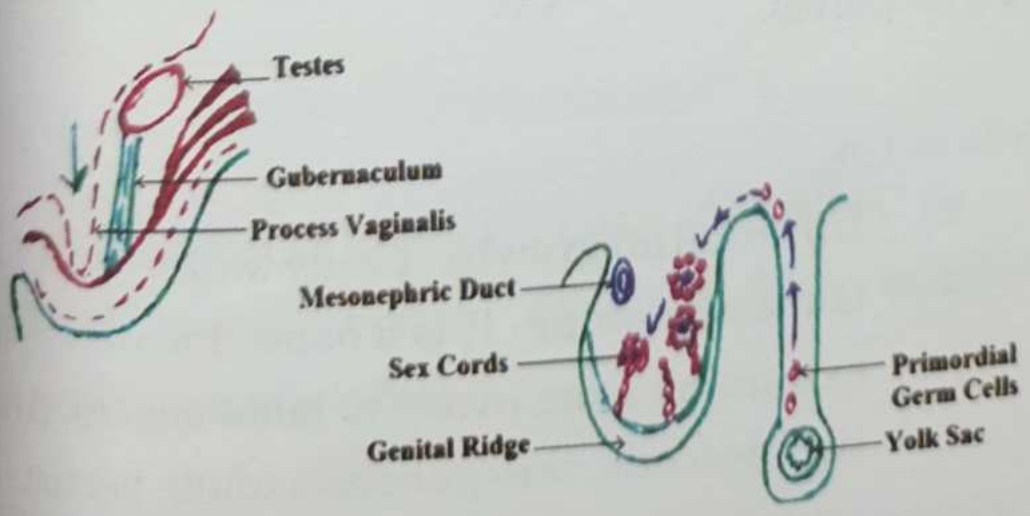

Fig.: Development of testes

DEVELOPMENT OF OVARY :

Stages of development are almost similar to that of testes.

- The coelomic epithelium on medial side of mesonephros become thick to form genital ridge.
- The cells of the ridge proliferate to form sex cords which grow into surrounding mesoderm.
- Primordial germ cells arise from wall of yolk sac and migrate into developing ovary. These germ cells are surrounded by cells sex cords to form primordial follicles.
- Coelomic epithelium persist as germinal epithelium

Descent of ovary :

The ovary is formed in lumbar region then it descents into true pelvis.

Factors for descent :

- Differential growth of body wall.
- Gubernaculum - It is a band of mesenchyme extending from ovary to labia majora. After the descent the gubernaculum persist as round ligament of ovary (Between ovary and uterus) and round ligament of uterus

(Between uterus and labia majora).

Anomalies :

1) Undescended ovary
2) Over descent into inguinal canal or labia majora.
3) Adrenal or thyroid tissue or undifferentiated cells can be found in ovary. They can give rise to a tumor called teratoma.

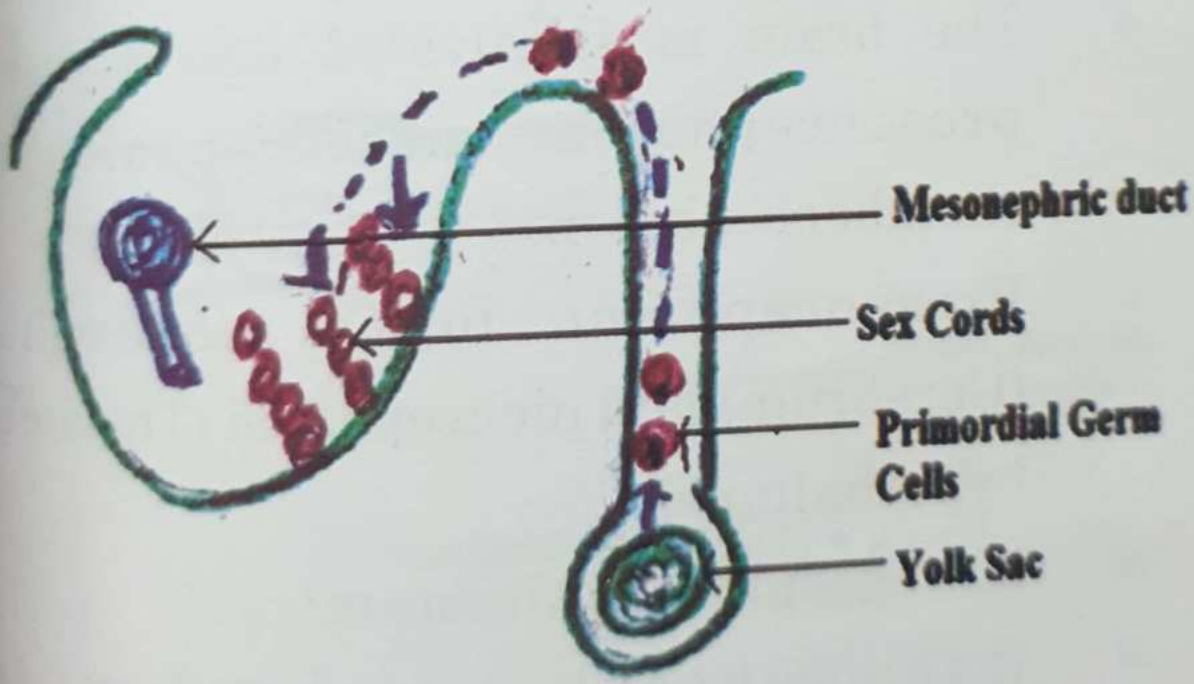

Fig Development of the ovary

SUPRARENAL GLAND :

It develops from two sources during 5th week.

1) The outer cortex develops from coelomic epithelium (Mesoderm) that lies between developing gonad and root of mesentry. The cells arising from the colomic epithelium are of two types.

- Larger cells surround the medulla and forms fetal cortex. It degenarates after

birth.

- Smaller cells surround the fetal cortex and forms the definitive cortex.
- The inner medulla is derived from neural crest cells.

Anomalies :

1) Ectopic adrenal tissue may be found in liver or within the capsule of kidney.
2) Congenital hyperplasia leads to adrenogenital syndrome and pseudoherma phroditism

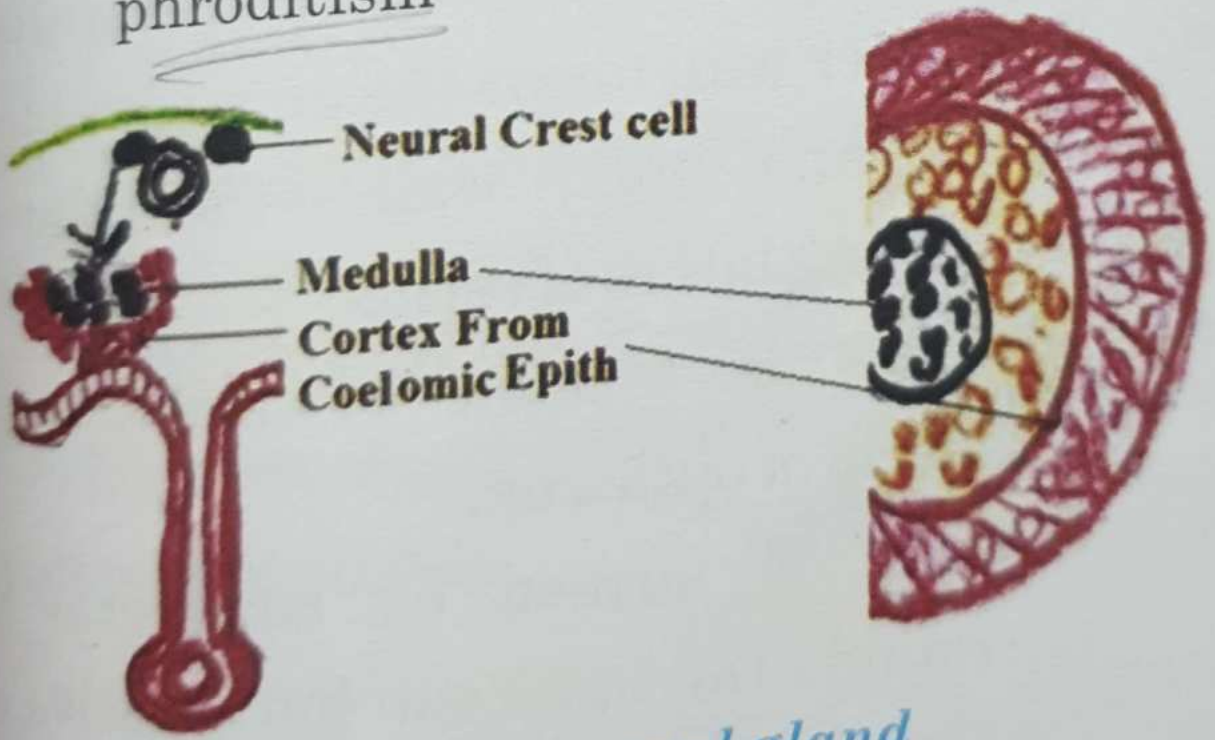

Fig Suprarenal gland

FATE OF GERM LAYERS :

Derivatives of ectoderm :

1) Skin
2) Melanoblasts
3) Mucous membrane of lip, cheeks, gums, floor of mouth, palate and nose.
4) Epithelium of lower part of anal canal, tip of urethra (male), outer surfaces of labia minora & labia majora.
5) Anterior surface of cornea, conjunctiva & Iris
6) Outer layer of tympanic membrane.
7) Sweat glands, sebaceous glands, parotid glands, mammary gland, lacrimal gland.
8) Pituitary gland and adrenal medulla.

9) Hair, nails, enamel of teeth, lens of eye
10) All parts of CNS except microglia.

Derivatives of endoderm :

1) Lining epithelium of part of mouth, tongue, tonsil, Pharynx esophagus, stomach, intestine & upper part of anal canal middle ear, inner surface of tympanic membrane, respiratory tract, gall bladder, extra hepatic ducts, urinary bladder (except trigone), urethra (except posterior wall), vagina & inner surface of labia minora.
2) Glands : Thyroid, parathyroids, thymus, islets of pancreas.
3) Liver, pancreas, all glands of GI tract & prostate (outer zone).

Derviatives of mesoderm :

1) All tissue, fascia, tendons, dermis, adipose tissue, cartilage bones & dentine of tooth.
2) All muscles of the body except muscles of iris
3) All parts of cardiovascular system.
4) Genitourinary systems.
5) Body cavities (lining).
6) Duramater & micoglial cells